

GAME TIME – HOW TO USE GAMIFICATION TO PROMOTE ACTIVE AND SUSTAINABLE TRAVEL

Claudia Stuerck
Aberdeenshire Council

1. INTRODUCTION

The Scottish Government aims to reduce carbon emissions by 80 per cent by 2032. With approximately one quarter of the annual carbon emissions, transportation is a significant contributor (cp. TRANSPORT SCOTLAND 2017). At the same time, transportation is one of the few sectors for which models predict a significant rise in carbon emissions, but, with no considerable political interventions, currently anticipated at approximately seven per cent by 2032 (IBID. 2017).

While new low carbon technologies hold the potential to significantly support the decarbonisation of transport emissions, their wide deployment is likely to take another 10 to 20 years (cp. COMMITTEE ON CLIMATE CHANGE 2013). In order to meet the Scottish Government's ambitious targets, measures to encourage more people to travel by more sustainable modes more often remain therefore key.

An innovative and promising approach in this context is gamification.

2. BACKGROUND

2.1 Gamification

Based on the high motivational potential of video games (cp. GARRIS, AHLERS and DRISKELL, 2002; RYAN, RIGBY, and PRZYBYLSKI 2006; YEE 2006; GEE 2007; PRZYBYLSKI, RIGBY and RYAN 2010; RIGBY and RYAN, 2011; HENSE and MANDL 2014), the concept of gamification has been the focus of increased attention since the beginning of the 2010s (DETERDING, DIXON, et al. 2011; WERBACH and HUNTER, 2012).

Gamification commonly refers to the “use of game design elements within non-game contexts” (DETERDING, DIXON, KHALED and NACKE 2011: p.1). WERBACH (2014) defines gamification as “the process of making activities more game-like” (IBID. p. 6). This paper draws on a definition that combines both of the above, and defines gamification as the process of making activities in non-game contexts more game-like by using game design elements.

SCHUNK, PINTRICH and MEECE (2010) conclude that the motivational potential of gamification supports efforts to encourage and sustain behaviour change (cp. also RIGBY and RYAN 2011).

Many authors, subsequently, consider gamification to be an important and promising concept that can be applied in a number of different contexts (cp. ZICHERMANN and

CUNNINGHAM 2011; WERBACH and HUNTER 2012 and ZICHERMANN and LINDER 2013). Gamification has been applied in the context of work (cp. ARAI, SAKAMOTO and WASHIZAKI, 2014; FERNANDES et al. 2012), education (cp. LANDERS and LANDERS, 2014; SHI, CRISTEA, HADZIDEDIC, and DERVISHALIDOVIC 2014), crowdsourcing (cp. LIU, ALEXANDROVA and NAKAJIMA, 2011; MEKLER, BRUEHLMANN, TUCH and OPWIS 2015), data-collection (cp. DOWNES-LE GUIN, BAKER, MECHLING and RUYLE 2012), health (cp. JONES, MADDEN and WENGREEN 2014), marketing (cp. HAMARI, 2013, 2015), social networks (cp. FARZAN and BRUSILOVSKY 2011), and environmental protection (cp. GUSTAFSSON, KATZEFF and BANG 2009).

This paper, subsequently, aims to better understand how and to what degree gamification can be applied to successfully motivate and encourage more people to travel more active and sustainably more often and to support behaviour change.

2.2 Game Design Elements

Several authors have identified different game design elements (cp. REEVES and READ 2009; ZICHERMANN and CUNNINGHAM 2011; KAPP 2012; WERBACH and HUNTER 2012 and ROBINSON and BALOTTI 2013). This paper does not aim to simply compile another list of characteristic game design elements. Instead it aims to identify and detail a selection of elements within the context of Pokémon Go¹ as per the below:

- **Tasks, Challenges:** Tasks are predefined challenges a player must overcome. If a task is completed successfully, the player receives a reward. For example, one of the tasks of Pokémon Go is to hatch so-called Pokémon Eggs, requiring the player to travel a set distance (two, five, or ten kilometres) on foot. Not knowing what Pokémon is going to hatch provides an additional element of surprise.
- **Points, Levels:** Points are rewarded for the successful accomplishment of specified tasks within the gamified context, representing a player's progress (WERBACH and HUNTER 2012, 2015), providing feedback and a reward (SAILER, HENSE, MANDL and KLEVERS 2013). Levels are defined sections in a player's progress. Only when a player has completed a level successfully and thus demonstrates sufficient abilities (e.g., catching and training Pokémons), they arrive at the subsequent next, higher and ever more difficult and challenging level.
- **Awards, Badges:** Awards and badges are defined as visual representations of achievements, reaching a certain number of points or successfully completing particular tasks within the game (RIGBY and RYAN 2011; WERBACH and HUNTER 2012). They serve as virtual social status symbols (ZICHERMANN and CUNNINGHAM, 2011), particularly if they are rare or hard to earn (ANTIN and CHURCHILL 2011; HAMARI, 2013). They encourage certain game dynamics when players choose to meet respective challenges in order to earn the badges that are associated with them (WANG and SUN 2011). Awards and

¹ Pokémon Go is often linked with increased walking levels since its launch in 2016 in relevant literature (cp. HELMHOLZ et al. 2017) and therefore considered to be of particular significance in the context of this paper to better understand how and to what degree gamification can help to encourage more people to travel more actively and sustainably more often.

badges also help to distinguish between players who have earned a particular award or badge and those who have not. In Pokémon Go, players collect Pokémons – some being rarer than others.

- (Real-Time) Feedback, Progress Bar: Feedback tells the player quickly and unambiguously how to rate their performance. When, for example, the experience points of a player within Pokémon Go increase, this is a clear indication that, there and then, the chosen action was correct. Progress bars also provide immediate and unambiguous feedback to the player about their performance within the game or gamified application (cp. NICHOLLS 1984; DWECK 1986; SAILER et al. 2013), illustrating which tasks have already been successfully completed and which tasks are still to be completed in order to progress to the next level. In Pokémon Go, players add to and complete a collection of Pokémons ("Gotta catch 'em all!") to further progress in the game.
- Augmented Reality: Pokémon Go uses the current location of the players (through GPS data) to position them within the game. The real environment is displayed on the smartphone as a walk-in map, thus providing a competitive platform indicating progress that relates the players' own performance to the performance of others (cp. CRUMLISH and MALONE 2009).
- Teams, Team Tasks: Creating defined groups of players that work together towards a shared objective supports cooperation (cp. KAPP 2012; WERBACH and HUNTER 2012). Being part of a team, it is more probable to successfully manage set tasks and to advance oneself and others in the game and to the next level. In Pokémon Go, players can join teams who attack and capture arenas together. In this context, the sense of relatedness is the key motivational element.

But why does gamification work?

2.3. Motivational Theory

In order to better understand how and to what degree gamification can be applied to successfully motivate and encourage more people to travel more active and sustainably more often and to support behaviour change, the following section considers gamification in the context of motivational theories. While there are a great number of motivational theories addressing different aspects of motivation that are to a certain degree relevant in the context of gamification (cp. SAILER et al. 2013; HENSE et al. 2014), this paper assumes that the successful application of gamification, in addition to stimulating intrinsic motivation, is based on imparting so-called flow experiences.

2.3.1 Self-Determination Theory

Building on Maslow's Hierarchy of Human Needs (cp. MASLOW 1943), in the past decades Deci's and Ryan's Self Determination Theory (Ryan and Deci 2000, 2017) has emerged as the principle framework for the study of intrinsic motivation and, has already been successfully applied in the context of games (cp. RYAN et al. 2006;

PRZYBYLSKI, RYAN and RIGBY 2009; PRZYBYLSKI, WEINSTEIN, RYAN and RIGBY 2009; PRZYBYLSKI et al 2010; RIGBY and PRZYBYLSKI 2009; RIGBY and RYAN 2011).

Intrinsic motivation refers to the spontaneous tendency “to seek out novelty and challenges, to extend and exercise one’s capacity, to explore, and to learn” (RYAN and DECI: 2000, p.70). When intrinsically motivated, people engage in an activity because they find it interesting and inherently satisfying. By contrast, when extrinsically motivated, people engage in an activity to obtain some instrumentally separable consequence, such as the attainment of a reward, the avoidance of a punishment, or the achievement of some valued outcome.

Within self-determination theory, three basic psychological and intrinsic needs are postulated (DECI and RYAN, 1985; RYAN, 1995; RYAN and DECI, 2002), including those for competence (feeling effective), autonomy (feeling volitional) and relatedness (feeling meaningfully connected with others).

DECI and RYAN also examined the situational factors (e.g., types of rewards, feedback) that facilitate or undermine the expression of intrinsic motivation (IBID. 2017) and made it clear that, by no means, is its expression automatic; rather, intrinsic motivation depends on adequate support for basic intrinsic psychological needs, especially those for competence and autonomy (cp. also VANSTEENKISTE et al. 2010).

2.3.2 Flow Theory

Aspects of intrinsic motivation have also been examined from perspectives other than DECI and RYAN’S Self Determination Theory. In this context, MIHALY CSIKSZENTMIHALYI’S (1975) Flow Theory is of particular importance. The close relation between DECI and RYAN’S self-determination theory concept of intrinsic motivation and CSIKSZENTMIHALYI (1990) concept of flow has been noted for a long time (DECI and RYAN 1985, 2000). Flow refers to experiential states of total absorption, optimal challenge, and non-self-conscious enjoyment of an activity. As with intrinsic motivation, when people experience flow, the satisfactions they experience are inherent to the activity itself and their behaviour is according to CSIKSZENTMIHALYI “autotelic” (auto = self, telos = goal) or performed for its own sake.

Flow Theory is particularly articulate in its description of the optimal challenges and ensuing competence satisfactions associated with intrinsic motivation. CSIKSZENTMIHALYI et al. (2014; p.90), for example, describe the flow state as the subjective experience of engaging “just-manageable challenges by tackling a series of goals, continuously processing feedback about progress, and adjusting action based on this feedback”, thus recognizing the intrinsically motivating aspects of flow activities.

Like Rigby and Ryan (2011), CSIKSZENTMIHALYI (2002) also considers game-like activities as particularly suited to specifically stimulate and sustain long-term flow experiences and, subsequently, intrinsically motivated behaviour.

Flow is therefore an essential part of successful game design. In order to get into the flow state, extrinsically and intrinsically motivating game design elements are combined. Tab. 1 provides an overview of the most important game design elements and differentiates between extrinsic and intrinsically motivating elements, whereby individual elements, depending on their application, can develop different game dynamics, each of which results in either extrinsic or intrinsic motivation. Collecting badges, for examples, is not just an intrinsically motivated behaviour, but also an extrinsically motivated aim of receiving external recognition from others (also see above for the game design elements discussed in the context of Pokémon Go).

Game Design Element	Motivational Outcome
Intrinsically motivating	
Tasks, Challenges	Flow Experience
Levels, Progress Points	Mastery
Progress Bars	(feeling volitional and effective)
Team Tasks, Challenges	Social Relatedness (feeling meaningfully connected)
Extrinsically motivating	
Points	Rewards (i.e., prizes)
Leader Boards	Rewards (i.e., recognition, social status)
Awards, Badges	Rewards (i.e., medals, certificates)
(Real-Time) Feedback	Reward (i.e., praise, accolades, commendations)

Tab.1 – Intrinsically and extrinsically motivating game design elements (after ENGEL 2016a, 2016b)

As gamification applies game design elements to make activities in non-game contexts such as everyday mobility more game-like, this paper assumes, therefore, that gamified applications can motivate and encourage travel behaviour change by stimulating intrinsic motives and motivation and, draws on a basic assumption of mobility psychology in that intrinsic motives exert a significant influence on mode choice (cp. STEG, VLEK and SLOTEGRAAF 2001; STEG 2005; SCHLAG and SCHADE 2007). People do not just want to drive to get from A to B. Driving a car is fun (perceived as flow).

To encourage and support behaviour change the intrinsic motives and motivation usually associated with driving need to be transferred to the more active and sustainable alternatives to the car (walking, cycling and passenger transport) so that their use is also perceived as flow.

3. POKÉMON GO

Current research links Pokémon Go to increased levels of physical activity (cp. HELMHOLZ et al. 2017). The following sections of this paper discusses Pokémon Go in the context of what a gamified application can achieve in connection with influencing everyday mode choice (see also ALTHOFF ET AL. 2016, MCCARTNEY 2016, RIMON 2016) in more detail.

First of all, players are required to move around in order to play Pokémon Go. The app uses GPS data to position players within the real world according to the principle

of augmented reality. They need to move to find and to catch the virtual Pokémons. The more the players move, the more likely they are to find the little monsters and to catch them. However, catching Pokémons is not possible if they move too fast, and players will only be able to hatch Pokémon Eggs if they travel two, five or ten kilometres in the real world at a maximum speed of 10.5 km/h. This equates to walking speed but can also be accomplished by cycling while adapting one's cycling speed.

According to recent studies, the daily walking distance of Pokémon Go players has increased significantly as a result of playing the game. On average, participants walked 7229 steps per day. According to researchers, this equates to around a quarter more steps compared to the step count of participants before playing Pokémon Go (cp. ALTHOFF et al. 2016). However, Pokémon Go is only to some extent suited to encourage behaviour change and motivate and encourage more people to travel more actively and more sustainably more often². This is due to its focus on pedestrian journeys which are only viable for short distances. Buses and trains are too fast to catch Pokémons or, to hatch Pokémon Eggs.

A basic assumption of this paper is that intrinsic motives have a decisive impact on mode choice behaviour (cp. SCHLAG and SCHADE 2007; STEG, VLEK and SLOTEGRAAF 2001, STEG 2005). Current research into the effects of Pokémon Go, although not entirely conclusive, generally supports the idea of gamified applications such as Pokémon Go which almost exclusively builds on intrinsically motivating game design elements to motivate and encourage behaviours by stimulating intrinsic motives and motivation. Current research also supports the idea that it is possible to transfer those intrinsic motives and motivations usually associated with driving a car to using more active and sustainable alternative modes of transport so that their use becomes more attractive. With Pokémon Go, walking becomes fun again (perception as flow).

This paper, subsequently, concludes that gamified applications are of particular interest and have a key role to play in encouraging mode shift and motivating more people to travel more actively and sustainably more often. Current research, while not conclusive, supports the hypothesis that intrinsically motivated behaviours hold the potential to reconsider and change habitual behaviours. The latter is usually unconscious and automated, so that traditional extrinsic incentives often are not successful in breaking those habits.

4. MODE CHOICE BEHAVIOUR CHANGE THEORY

4.1 Key Principles

However, in order to successfully apply gamification and set appropriate stimuli (cp. ORTIZ DE GUINEA and MARKUS 2009) to support travel behaviour change it is essential to understand the processes behind the decision to engage in and then

² It should be noted, however, that Pokémon Go was not developed with the intention to motivate and encourage more people to walk more often.

maintain travelling more active and sustainably more often. This paper, therefore, draws on BAMBERG'S Stage Model of Self-Regulated Behaviour Change (SSBC) (IBID. 2012, 2013a, 2013b). With the SSBC, BAMBERG presents for the first time a model that logically represents the process of behavioural change in connection with mode choice behaviour. BAMBERG assumes that people have a different motivational readiness to change their mobility behaviour, distinguishing four stages:

Stage 1: Pre-Decision. Individuals in this stage typically make most of their trips by car, are quite happy with the way they currently travel (i.e. as car drivers) and at the moment have no intention, or desire to change to another mode, or feel that it would be impossible for them to do so at the present time, whether this be through subjective or objective reasons.

Stage 2: Pre-Action. Individuals in this stage typically make most of their trips by car but, other than individuals in the pre-decision stage, are not as content with their current travel behaviour. While they would like to reduce their number of car trips and change to a more active and more sustainable alternative, they are still unsure of which mode to shift to, or perhaps they do not have the confidence to do so. They are not really sure which alternative mode(s) they could use for their trip purposes, or, indeed, when they will begin replacing their car trips.

Stage 3: Action. Individuals in this stage typically still make most of their trips by car, but have firmly decided which alternative mode they want to use instead for some or, all of their trips, they have the confidence to do so and may have already tried this new mode for some of their trips.

Stage 4: Post-Action. Individuals in this stage typically make most or all of their trips by active and sustainable alternative modes (passenger transport, walking, cycling etc.). Individuals in this stage either do not own or, have access to a car and are therefore dependent on non-car modes for their trips or, they own or, have access to a car but for various reasons choose to drive only for some of their trips, very infrequently or, not at all.

With the Stage Model of Self-Regulated Behavioural Change, BAMBERG presents a model for travel behaviour change that, in the opinion of the author of this paper, is much better suited as a framework for the development of gamified applications to successfully motivate and encourage more people to travel more active and sustainably more often. BAMBERG (2012, 2013a, 2013b) argues that the setting of appropriate stimuli in accordance with the motivational readiness, can, support and promote the formulation of binding intentions in accordance with the SSBC.

4.2 A Possible SSBC Stage-Tailored Application of Gamification

The following sections of this paper aim to apply the SSBC in the development of a stage-tailored gamified approach aimed at encouraging and supporting travel behaviour change.

According to the Stage Model of Self-Regulated Behavioural Change, people at the pre-decisional stage are satisfied with their current behaviour and, subsequently, do not see any need to change it. At this stage, habitual car drivers do not intend to restrict their car use in the future. It is therefore important to provide information that

raises awareness and an understanding of the problem and, at the same time, highlights the contradiction between the behaviour and own personal standards and values, subsequently increasing their insight that a behaviour change is both necessary and, most importantly, possible. However, it should be noted in this regard that applications perceived by pre-decisional users as direct criticisms of their current behaviour are likely to trigger reactance (cp. BREHM 1966). Thus, at the pre-decisional stage, game design elements that introduce the subject of sustainable mobility and, in this context, draw attention to the various problems resulting from indiscriminate car use, are of particular significance. Conceivable in this context are thematic quiz or knowledge games in the course of which points are collected.

According to the Stage Model of Self-Regulated Behavioural Change, people at the pre-actionary stage already intend to change their behaviour and, for example, restrict their car use, and set this to their personal goal. However, individuals at this level have not yet determined how and when they personally implement this intention. Therefore, game elements at the pre-reactionary level should aim at highlighting alternatives, taking into account the data collected at the beginning, for example by providing information including a link with a timetable information (i.e. Traveline Scotland) and provide people with the opportunity to, for example, trial passenger transport by giving them a free weekly bus ticket (also cp. KNOWLES and RINER 2007). When the proposals are implemented, people are rewarded.

According to the Stage Model of Self-Regulated Behavioural Change, people at the actional stage do not only have a strong intention to change their current travel behaviour, but have already decided for them about a suitable alternative mode. The latter might have already been occasionally tried and tested. Subsequently, game design elements at this level should encourage people to continue to walk and cycle and, to use passenger transport by still rewarding their use. However, as mentioned above, intrinsically motivating game elements are essential for long-term motivation and lasting behaviour change (cp. SMADJA 2009). Therefore, a transition away from the extrinsically motivating game design elements to intrinsically motivating elements has to be initiated at this stage with first tasks and challenges to be set within the application, such as by introducing increasingly difficult and challenging levels. For example, while in the beginning using the car could still be a valid option within the game, over time, only the use of more active and sustainable modes leads to progress in the game.

The increased challenges coupled with curiosity about what the next level involve are intrinsically motivating and help to encourage and motivate people to continue to play the game and, at the same time, increase their competence with regard to travelling more active and sustainably more everyday purposes.

At the post-actual stage, mode choices have changed and have, over time, become a habit. According to the Stage Model of Self-Regulated Behavioural Change, people at this stage almost exclusively choose to walk, cycle or, to use busses and trains for their everyday journey purposes. Game design elements at this level should therefore aim to help to sustain the behaviour and perhaps even increase it. For example, introducing augmented reality is a potential option at this stage. For example, a blank area map could be revealed step by step by performing tasks related to the walking and cycling network in the respective area, as well as the bus and train networks. It could be a task to travel with the various bus lines covering the area or, to use all the bus stops or train stations in the area.

According to BAMBERG (2012, 2013a, 2013b), people who already regularly walk and cycle or travel by bus or train because they do not own a car also have to be considered at this stage, as they should be encouraged in their active and sustainable travel choices and to discourage them from considering buying a car in the short, medium and long term.

5. ACCEPTANCE OF A GAMIFIED APPROACH IN THE CONTEXT OF MODE CHOICE BEHAVIOUR CHANGE INTERVENTIONS

ENGEL and HAHN (2016b) researched the acceptance of game design elements in connection with influencing mode choice in an urban context. Participants in the study were at least 16 years old and travelled regularly, i.e. at least once a week, in urban traffic. During the survey participants had the opportunity to choose from various intrinsically and extrinsically motivating game design elements. They were asked to select the elements that they considered motivating to encourage them to change and either use passenger transport or walk and cycle or, at least, use those active and sustainable modes more often.

The research showed that drivers, regardless of how often they use the car in a day, in most cases selected at least one game design element which would motivate them to change. This alone shows that gamified applications are accepted in the context of travel behaviour change interventions.

6. SUMMARY – CONCLUSIONS

This paper aims to better understand how and to what degree gamification can be applied to successfully motivate and encourage more people to travel more active and sustainably more often and to support lasting behaviour change.

Current approaches to encourage mode choice, such as Personalised Travel Planning (PTP) initiatives, rely almost exclusively on extrinsically motivating incentives. While those initiatives initially report mode shift in the short term, there is still no clear evidence that external incentives are sufficient to successfully stimulate and eventually sustain behaviour change in the medium to long term.

Drawing on current research with regard to travel and transport psychology, this paper emphasizes the significance of intrinsically motivated decisions in the context of mode choice behaviour. Assuming that successful travel behaviour change is dependent on stimulating intrinsic motives and motivation in the context of choosing to walk and cycle and, choosing to go by bus or train, it becomes evident that current approaches cannot achieve this. They almost exclusively rely on extrinsically motivating incentives.

Drawing on current research in relation to Pokémon Go in the context of DECI and RYAN'S Self-Determination Theory and CSIKSZENTMIHALYI Flow Theory, the paper establishes that gamified applications which almost exclusively build on intrinsically motivating game design elements are able to motivate and encourage behaviours by stimulating intrinsic motives and motivation. Current research also supports the idea

that it is possible to transfer those intrinsic motives and motivations usually associated with driving a car to using more active and sustainable alternative modes of transport so that their use becomes more attractive.

Since the development of effective and efficient gamified applications aiming to encourage more people to travel more actively and sustainably more often requires a thorough understanding of the respective principles and processes underlying behaviour change, this paper discusses BAMBERG'S Stage Model of Self-Regulated Behavioural Change which was specifically developed in relation to mode choice behaviour. With the Stage Model of Self-Regulated Behavioural Change, BAMBERG presents a model for travel behaviour change that, in the opinion of the author of this paper, is much better suited as a framework for the development of gamified applications to successfully motivate and encourage more people to travel more active and sustainably more often. It acknowledges the self-regulated character of behaviour change and, subsequently, provided a framework for setting appropriate stimuli in accordance with the motivational readiness to encourage and support behaviour change in the medium to long term.

Finally drawing on current research into the acceptance of gamified application specifically within the context of mode choice behaviour in an urban context, the paper establishes that car drivers, regardless of how often they use the car in a day, in most cases selected at least one game design element which would motivate them to change. In the opinion of the author of this paper, this alone shows that gamified applications will be accepted in the context of behaviour change in a transport context.

The conclusions of this paper are relevant for developing transport policy and strategy in that they identified gamification as being a powerful tool to address motivational issues within the context of mode choice behaviour. All the more, as with the Generation Y, often referred to as the first Digital Natives (cp. EUROMONITOR 2015), transport planners see a generation coming through who expect game design elements in non-gaming contexts. Subsequently, gamification holds a considerable potential as a successful communication and motivation tool for this target group (cp. BURKE and HILTBRAND 2011) as long as the gamified applications are well designed and implemented.

BIBLIOGRAPHY

Ajzen, I. (1991). The Theory of Planned Behavior. In: *Organizational Behavior and Human Decision Processes*, 50, pp.179-211.

Althoff, T., White, R. W., Horvitz, E. (2016). Influence of Pokémon Go on Physical Activity: Study and Implications, Microsoft Research
<https://arxiv.org/pdf/1610.02085v1.pdf>

Anderson, A., Huttenlocher, D., Kleinberg, J., Leskovec, J. (2013). Steering User Behavior with Badges. Paper presented at the 22nd International Conference on World Wide Web, Rio de Janeiro.

Annetta, L. A. (2010). The “I’s” Have It: A Framework for Serious Educational Game Design. In: *Review of General Psychology*, 14(2), pp.105-112.

Antin, J., Churchill, E. F. (2011). Badges in Social Media: A Social Psychological Perspective. Paper presented at the CHI 2011, Vancouver.

Arai, S., Sakamoto, K., Washizaki, H. (2014). A Gamified Tool for Motivating Developers to Remove Warnings of Bug Pattern Tools. Paper presented at the IWESep 2014, Osaka.

Baard, P., Deci, E., Ryan, R. (2004). Intrinsic Need Satisfaction: A Motivational Basis of Performance and Well-Being in Two Work Settings. In: *Journal of Applied Social Psychology*, 34 (10), pp.2045–2068.

Bamberg, S. (2012). Understanding and Promoting Bicycle Use – Insights from Psychological Research. In: J. Parkin (Eds.), *Transport and Sustainability*, Vol. 1 - Cycling and Sustainability, (pp.219-246). UK: Emerald.

Bamberg, S. (2011). Processes of Change. In: Steg, L., van den Berg A. E., de Groot J. I. M. (Eds.), *Environmental Psychology: An Introduction* (pp.267-280). Chichester, UK: Wiley.

Bamberg, S. (2012). Wie Funktioniert Verhaltensaenderung. Das MAX-Selbstregulierungsmodell. In: Stiewe, M., Reutter, U. (Eds): *Mobilitaetsmanagement. Wissenschaftliche Grundlagen und Wirkungen in der Praxis*, pp.76-101, Essen: Klartext-Verlag

Bamberg, S. (2013a). Changing Environmentally Harmful Behaviors: A Stage Model of Self-Regulated Behavioral Change. In: *Journal of Environmental Psychology*, 34, pp.151-159.

Bamberg, S. (2013b). Applying the Stage Model of Self-Regulated Behavioral Change in a Car Use Reduction Intervention. In: *Journal of Environmental Psychology*, 33, pp.68-75.

Bamberg, S. (2014). Psychological Contributions to the Development of Car Use Reduction Interventions. In: T. Gärling, D. Ettema, M. Friman (Eds.), *Handbook of Sustainable Travel*, (pp.131-149). Berlin/NY: Springer.

Bénabou, R., Tirole, J. (2003). Intrinsic and Extrinsic Motivation. In: *The Review of Economic Studies*, 70 (3), pp.489–520.

Blohm, I., Leimeister, J. M. (2013). Gamification. In: *Wirtschaftsinformatik*, 55, pp.275-278.

Brehm, J. W. (1966). *Theory of Psychological Reactance*. New York, Academic Press.

Brög W., Erl E., Ker I., Ryle J., Wall R. (2009). Evaluation of Voluntary Travel Behaviour Change: Experiences from Three Continents. In: *Transport Policy*, 16, pp.281-292.

Burke, M., Hiltbrand, T. (2011). How Gamification Will Change Business Intelligence. In: *Business Intelligence Journal*, 16 (2), pp.8–16.

Burke, B. (2012). NOT Gamification 2020: What Is The Future Of Gamification? Gartner. <https://www.gartner.com/doc/2226015/gamification--future-gamification>

Crumlish, C., Malone, E. (2009). *Designing Social Interfaces: Principles, Patterns and Practices for Improving the User Experience*. Sebastopol: O'Reilly Media, Inc.

Csikszentmihályi, M. (1975). *Beyond Boredom and Anxiety - The Experience of Play* In: *Work And Games*. San Francisco/Washington/London: Jossey-Bass Inc.

Csikszentmihályi, M. (1990). *Flow: The Psychology of Optimal Experience*. New York, NY: Harper and Row.

Csikszentmihályi, M. (1993). *The Evolving Self: A Psychology for the Third Millenium*. New York: Haper Collins Publishers Inc.

Csikszentmihalyi, M. (2007). *Finding Flow*.

Deci, E. L. (1972). Intrinsic Motivation, Extrinsic Reinforcement and Inequity. In: *Journal of Personality and Social Psychology*, 22 (1), pp.113-120.

Deci, E. L. (1975). *Intrinsic Motivation*. New York/London: Springer.

Deci, E. L. (1971). Effects of Externally Mediated Rewards on Intrinsic Motivation. In: *Journal of Personality and Social Psychology*, 18 (1), pp.105–115.

Deci, E. L., Cascio, W. F. (1972). Changes in Intrinsic Motivation as a Function of Negative Feedback and Threats. Presented at the Meeting of the Eastern Psychological Association, pp.1–24.

Deci, E. L., Ryan, R. M. (1985). *Intrinsic Motivation and Self-Determination in Human Behavior*. New York: Springer.

Deci, E. L., Ryan, R. M. (1993). Die Selbstbestimmungstheorie der Motivation. *Zeitschrift für Pädagogik*, 39 (2), pp.223-238.

Deci, E. L., Ryan, R. M. (2000). The "What" and "Why" of Goal Pursuits: Human Needs and the Self-Determination of Behavior. In: *Psychological Inquiry*, 11(4), pp.227-268.

Deci, E. L., Vansteenkiste, M. (2004). Self-Determination Theory and Basic Need Satisfaction: Understanding Human Development in Positive Psychology. In: *Ricerche di Psicologia*, 27(1), pp.23-40.

Deci, E. L., Ryan, R. M. (2012). Motivation, Personality, and Development within Embedded Social Contexts: An Overview of Self-Determination Theory. In: R. M. Ryan (Ed.), *The Oxford Handbook of Human Motivation* (pp.1-59). Oxford: Oxford University Press.

Deterding, S. (2011). Situated Motivational Affordances Of Game Elements: A Conceptual Model. In: *CHI*, pp.3–6.

Deterding, S. (2012). Gamification: Designing For Motivation. In: *Social Mediator*, 19 (4), pp.14–17.

Deterding, S. (2013). *Modes Of Play A Frame Analytic Account Of Video Game Play*. Dissertation. Universität Hamburg.

Deterding, S., Dixon, D., Khaled, R., Nacke, L. (2011). From Game Design Elements to Gamefulness: Defining "Gamification". Paper presented at the 15th International Academic MindTrek Conference Envisioning Future Media Environments, Tampere.

Deterding, S., Khaled, R., Nacke, L., Dixon, D. (2011). Gamification: Toward a Definition. Paper presented at the CHI 2011, Vancouver.

Downes-Le Guin, T., Baker, R., Mechling, J., Ruyle, E. (2012). Myths and Realities of Respondent Engagement in Online Surveys. In: *International Journal of Market Research*, 54(5), pp.1-21.

Dweck, C. S. (1986). Motivational Processes Affecting Learning. In: *American Psychologist*, 41(10), pp.1040-1048.

Engel, T. (2016a): Pokemon Go – eine App die Bewegt. In *Verkehrszeichen* 4(2016), pp.19-23.

Engel, T. (2016b): Spielerisch wechseln - Beeinflussung der Verkehrsmittelwahl durch Gamification, Technische Universitaet Kaiserslautern.

Euromonitor. (2015a). Euromonitor Statistics – International. <http://www.portal.euromonitor.com/portal/statistics/tab>

Euromonitor. (2015b). Top Ten Global Consumer Trends for 2015. Euromonitor International. <http://www.portal.euromonitor.com/portal/analysis/tab>

Farzan, R., Brusilovsky, P. (2011). Encouraging User Participation in a Course Recommender System: An Impact on User Behavior. In: Computers in Human Behavior, 27(1), pp.276-284.

Fernandes, J., Duarte, D., Ribeiro, C., Farinha, C., Pereira, J. M., & Silva, M. M. d (2012). iThink: A Game-Based Approach towards Improving Collaboration and Participation in Requirement Elicitation. In: Procedia Computer Science, 15, pp.66-77.

Garris, R., Ahlers, R., Driskell, J. E. (2002). Games, Motivation and Learning: A Research and Practice Model. In: Simulation & Gaming, 33(4), pp.441-467.

Gartner. (2011). Gartner Predicts Over 70 Percent of Global 2000 Organisations Will Have at Least One Gamified Application by 2014. <http://www.gartner.com/newsroom/id/1844115>

Gartner. (2012). Gartner Says By 2014, 80 Percent of Current Gamified Applications Will Fail to Meet Business Objectives Primarily Due To Poor Design. <http://www.gartner.com/newsroom/id/2251015>

Gee, J. P. (2007). Good Video Games and Good Learning: Collected Essays on Video Games, Learning, and Literacy. New York: Peter Lang International Academic Publishers.

Gollwitzer, P. M. (1990). Action Phases and Mind-Sets. In E. T. Higgins, R. M. Sorrentino (Eds.). In: Handbook of Motivation and Cognition: Foundations of Social Behavior, Vol. 2 (pp.53-92). New York, NY: Guilford.

Gollwitzer, P. M. (1999). Implementation Intentions: Strong Effects of Simple Plans. American Psychologist, 54, pp.493-503.

Gustafsson, A., Katzeff, C., Bang, M. (2009). Evaluation of a Pervasive Game for Domestic Energy Engagement among Teenagers. In: Computers in Entertainment (CIE), 7(4), p.54.

Hamari, J. (2013). Transforming Homo Economicus into Homo Ludens: A field Experiment on Gamification in a Utilitarian Peer-to-Peer Trading Service. In: Electronic Commerce Research and Applications, 12(4), pp.236-245.

Hamari, J., Koivisto, J. (2013). Social Motivations to Use Gamification: An Empirical Study Of Gamifying Exercise. In: Proceedings of the 21st European Conference on Information Systems. Utrecht, Netherlands.

Hamari, J. (2015). Do Badges Increase User Activity? A Field Experiment on the Effects of Gamification. Computers in Human Behavior.

Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does Gamification Work? - A Literature Review of Empirical Studies on Gamification. Paper presented at the 47th Hawaii International Conference on System Sciences, Waikoloa.

Hamari, J., Koivisto, J. (2014). Measuring Flow in Gamification: Dispositional Flow Scale-2. In: Computers in Human Behavior, 40, pp.133-143.

Hamari, J., Shernoff, D. J., Rowe, E., Coller, B., Asbell-Clarke, J., Edwards, T. (2016). Challenging Games Help Students Learn: An Empirical Study on Engagement, Flow and Immersion in Game-based Learning. In: Computers in Human Behavior, 54, pp.170-179.

Helmholz, P.; Eckardt, L.; Becker, F.; Meyer, M.; Robra-Bissantz, S. (2017): Catch them all! Pokémon Go Führt zu Steigender Physischer Aktivität und Sozialer Zugehörigkeit. In: Proceedings of 20th GeNeMe-Tagung, Dresden.

Hense, J., Klevers, M., Sailer, M., Horenburg, T., Mandl, H., & Günthner, W. (2014). Using Gamification to Enhance Staff Motivation in Logistics. In S. A. Meijer, R. Smeds (Eds.), In: Frontiers in Gaming Simulation (pp.206-213). Stockholm: Springer.

Huotari K, Hamari J (2012) Defining Gamification – A Service Marketing Perspective. In: Proceedings 15th MindTrek Conference Envisioning Future Media Environments, Tampere, pp.17-22.

Huizinga, J. (1955). Homo Ludens - A Study of the Play Element in Culture. Boston: Beacon Press.

Intrinsic Motivation Inventory. (1994). Intrinsic Motivation Inventory (IMI). The Intrinsic Motivation Inventory, Scale Description, 1–3.
<http://selfdeterminationtheory.org/intrinsic-motivation-inventory>

Jones, B. A., Madden, G. J., Wengreen, H. J. (2014). The FIT Game: Preliminary Evaluation of a Gamification Approach to Increasing Fruit and Vegetable Consumption in School. In: Preventive Medicine, 68, pp.76-79.

Kapp, K. M. (2012). The Gamification of Learning and Instruction: Game-based Methods and Strategies for Training and Education. San Francisco: Pfeiffer.

Knowles, E. S., Riner, D. D. (2007). Omega Approaches to Persuasion: Overcoming Resistance. In A. R. Pratkanis (Ed.), In: The Science of Social Influence, pp.83-114. New York, NY: Psychology Press

Landers, R. N., Landers, A. K. (2014). An Empirical Test of the Theory of Gamified Learning: The Effect of Leaderboards on Time-on-Task and Academic Performance. In: Simulation & Gaming, 45(6), pp.769-785.

Liu, Y., Alexandrova, T., Nakajima, T. (2011). Gamifying Intelligent Environments. Paper presented at the 2011 International ACM Workshop on Ubiquitous Meta User Interfaces, Scottsdale.

Marczewski, A. (2013). Gamification: A Simple Introduction and a Bit More - Tips, Advice and Thoughts on Gamification (2nd ed.): Self-Published by Andrzej Marczewski.

Maslow, A. H. (1943). A Theory of Human Motivation. *Psychological Review*, 50(4), pp. 370-96.

McCartney M. (2016). Game on for Pokémon Go.
<https://www.bmj.com/content/354/bmj.i4306>.

McGonigal, J. (2011). *Reality is Broken: Why Games Make Us Better and How They Can Change the World*. New York: Penguin Group.

Mekler, E. D., Brühlmann, F., Tuch, A. N., Opwis, K. (2015). Towards Understanding the Effects of Individual Gamification Elements on Intrinsic Motivation and Performance. In: *Computers in Human Behavior*.

Möser, G., Bamberg, S. (2008). The Effectiveness of Soft Transport Policy Measures: A Critical Assessment and Meta-Analysis of Empirical Evidence. In: *Journal of Environmental Psychology*, 28, pp.10-26.

Nicholls, J. G. (1984). Achievement Motivation: Conceptions of Ability, Subjective Experience, Task Choice, and Performance. In: *Psychological Review*, 91(3), pp.328-346.

Nicholson, S. (2015). A RECIPE for Meaningful Gamification. In T. Reiners, L. C. Wood (Eds.), In: *Gamification in Education and Business* (pp.1-20). New York: Springer.

Ortiz de Guinea A, Markus ML (2009) Why Break the Habit of a Lifetime? Rethinking the Roles of Intention, Habit, and Emotion in Continuing Information Technology Use. In: *MIS Quarterly* 33(3), pp.433-444.

Przybylski, A. K., Rigby, C. S., & Ryan, R. M. (2010). A Motivational Model of Video Game Engagement. In: *Review of General Psychology*, 14(2), pp.154-166.

Przybylski, A. K., Ryan, R. M., & Rigby, C. S. (2009). The Motivating Role of Violence in Video Games. In: *Personality and Social Psychology Bulletin*, 35(2), pp.243-259.

Przybylski, A. K., Weinstein, N., Ryan, R. M., & Rigby, C. S. (2009). Having to versus Wanting to Play: Background and Consequences of Harmonious versus Obsessive Engagement in Video Games. *CyberPsychology & Behavior*, 12(5), pp.485-492.

Rackwitz, R. (2016). Was ist Gamification?
<https://www.youtube.com/watch?v=Lb87TdjglYw>

Rackwitz, R. (2016). Gamification – Human Performance Design.
https://www.youtube.com/watch?v=jQnB_OwY7MA

Reeve, J., Deci, E. L. (1996). Elements of the Competitive Situation that Affect Intrinsic Motivation. *Personality and Social Psychology Bulletin*, 22 (1), pp.24-33.

Reeves, B., Read, J. L. (2009). *Total Engagement: Using Games and Virtual Worlds to Change the Way People Work and Businesses Compete*. Boston: Harvard Business School Press.

Rheinberg, F., Vollmeyer, R., Engeser, S. (2003). Die Erfassung des Flow-Erlebens. In J. Stiensmeier-Pelster, F. Rheinberg (Eds.). In: *Diagnostik von Motivation und Selbstkonzept*, pp. 61-279, Göttingen: Hogrefe.

Rigby, C. S. (2012). *Intrinsic and Extrinsic Player Motivation: Implications for Design and Player Retention*. Game Developers Conference. San Francisco.

Rigby, C. S., Przybylski, A. K. (2009). Virtual Worlds and the Learner Hero: How Today's Video Games Can Inform Tomorrow's Digital Learning Environments. In: *Theory and Research in Education*, 7(2), pp.214-223. .

Rigby, C. S., Ryan, R. M. (2011). *Glued to Games: How Video Games Draw Us in and Hold Us Spellbound*. Santa Barbara: Praeger.

Rimon, G. (2016): *How Pokémon GO Relates To Gamification In The Workplace*.
<https://elearningindustry.com/pokemon-go-gamification-in-the-workplace>

Robinson, D., Bellotti, V. (2013). *A Preliminary Taxonomy of Gamification Elements for Varying Anticipated Commitment*. Paper presented at the CHI 2013, Paris.

Ryan, R. M. (1982). Control and Information in the Intrapersonal Sphere: An Extension of Cognitive Evaluation Theory. In: *Journal of Personality and Social Psychology*, 43 (3), pp.450-461.

Ryan, R. M. (1995). Psychological Needs and the Facilitation of Integrative Processes. *Journal of personality*, 63(3), pp.397-427.

Ryan, R. M., Deci, E. L. (2000a). Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. In: *Contemporary Educational Psychology*, 25 (1), pp.54-67.

Ryan, R. M., Deci, E. (2000b). Self-Determination Theory and the Facilitation of Intrinsic Motivation. In: *American Psychologist*, 55 (1), pp.68-78.

Ryan, R. M., Deci, E. L. (2002). Overview of Self-Determination Theory: An Organismic Dialectical Perspective. In: R. M. Ryan, E. L. Deci (Eds.), *Handbook of Self-Determination Research* (pp.3-33). Rochester: University of Rochester Press.

Ryan, R. M., Mims, V., Koestner, R. (1983). Relation of Reward Contingency and Interpersonal Context to Intrinsic motivation: A Review and Test Using Cognitive Evaluation Theory. In: *Journal of Personality and Social Psychology*, 45(4), pp.736-750.

Ryan, R. M., Rigby, C. S., Przybylski, A. K. (2006). The Motivational Pull of Video Games: A Self-Determination Theory Approach. In: Motivation and Emotion, 30(4), pp.344-360.

Sailer, M., Hense, J., Mandl, H., Klevers, M. (2013). Psychological Perspectives on Motivation through Gamification. In: Interaction Design and Architecture(s) Journal, 19, pp.28-37.

Salen, K., Zimmerman, E. (2004). Rules of Play: Game Design Fundamentals. Cambridge: Mit Press.

Schilling, D. (2016). Is Pokémon Go the Answer to America's Obesity Problem? The Guardian. 13 July 2016. <https://www.theguardian.com/commentisfree/2016/jul/13/is-pokemon-go-the-answer-to-obesity-america>

Schlag, B., Schade, J. (2007). Psychologie des Mobilitätsverhaltens. In: Aus Politik und Zeitgeschichte, APUZ 29-30/2007, Bundeszentrale fuer Politische Bildung. <http://www.bpb.de/apuz/30341/verkehrspolitik>

Schunk, D. H., Pintrich, P. R., Meece, J. L. (2010). Motivation in Education: Theory, Research, and Applications (3rd ed.). Upper Saddle River: Pearson.

Seaborn, K., Fels, D. I. (2015). Gamification in Theory and Action: A Survey. In: International Journal of Human Computer Studies, 74, pp.14-31.

Shi, L., Cristea, A. I., Hadzidedic, S., Dervishalidovic, N. (2014). Contextual Gamification of Social Interaction towards Increasing Motivation in Social Elearning. In: E. Popescu, R. H. Lau, K. Pata, H. Leung, M. Laanpere (Eds.), Advances in Web-Based Learning ICWL 2014, pp.116-122, Tallinn: Springer.

Siemens, J. C., Smith, S., Fisher, D., Thyroff, A., Killian, G. (2015). Level Up! The Role of Progress Feedback Type for Encouraging Intrinsic Motivation and Positive Brand Attitudes. In: Public Versus Private Gaming Contexts. Journal of Interactive Marketing, 32, pp.1-12.

Smadja, F. (2009). Mixing Financial, Social and Fun Incentives for Social Voting. 1. International Workshop on Motivation and Incentives on the Web at the 18th International World Wide Web Conference, WWW2009, Madrid.

Spiegel Online. (2016). Kellner Schmeißt Job Für Pokémon-Reise Durch Neuseeland. Spiegel Online, 20 Jul 2016. <http://www.spiegel.de/reise/aktuell/pokemon-go-neuseelaender-kuendigt-job-fuer-monsterjagd-a-1100423.html>

Steg, L (2005). Car use: lust and must. Instrumental, symbolic and affective motives for car use. In: Transportation Research Part A 39 (2005), pp. 147-162. <https://www.rug.nl/staff/e.m.steg/steglustandmust.pdf>

Steg, L., Vlek, C., Slotegraaf, G. (2001). Instrumental-Reasoned and Symbolic Affective Motives for Using a Motor Car. In: Transport Research Part F(4) (2001), pp. 151-169. <https://www.ruq.nl/staff/e.m.steg/stegvlekslotegraaf.pdf>

University of Leicester. Press release: Pokémon Go Could Ease Type 2 Diabetes Burden. 25 Jul 2016. <https://www2.le.ac.uk/offices/press/press-releases/2016/july/2018pokemon-go-could-ease-type-2-diabetes-burden2019>

Vansteenkiste, M., Niemiec, C. P., Soenens, B. (2010). The Development of the Five Mini-Theories of Self-determination Theory: An Historical Overview, Emerging Trends, and Future Directions. In: T. C. Urdan, S. A. Karabenick (Eds.), *The Decade Ahead: Theoretical Perspectives on Motivation and Achievement (Advances in Motivation and Achievement (Vol. 16 A, pp.105-165)*. London: Emerald Group Publishing Limited.

Vansteenkiste, M., Ryan, R. M. (2013). On Psychological Growth and Vulnerability: Basic Psychological Need Satisfaction and Need Frustration as a Unifying Principle. In: *Journal of Psychotherapy Integration*, 23(3), pp.263-280.

Vansteenkiste, M., Williams, G. C., Resnicow, K. (2012). Toward Systematic Integration between Self-Determination Theory and Motivational Interviewing as Examples of Top-Down and Bottom-Up Intervention Development: Autonomy or Volition as a Fundamental Theoretical Principle. In: *International Journal of Behavioral Nutrition and Physical Activity*, 9(23).

Vallerand, R. J. (2000). Deci and Ryan's Self-Determination Theory: A View from the Hierarchical Model of Intrinsic and Extrinsic Motivation. *Psychological Inquiry*, 11 (4), pp. 312–318, 345.

Vallerand, R. J., Reid, G. (1984). On The Causal Effects of Perceived Competence on Intrinsic Motivation: A Test of Cognitive Evaluation Theory. In: *Journal of Sport Psychology in Action*, 6 (d), pp.94-102.

Wang, H., Sun, C.-T. (2011). Game Reward Systems: Gaming Experiences and Social Meanings. Paper presented at the DiGRA 2011 Conference: Think Design Play, Hilversum.

Werbach, K., Hunter, D. (2012). *For The Win - How Game Thinking Can Revolutionize Your Business*. Philadelphia, PA: Wharton Digital Press.

Werbach, K. (2014). (Re)defining Gamification: A Process Approach. In A. Spagnolli, L. Chittaro, L. Gamberini (Eds.), *Persuasive Technology (Vol. 8462, pp.266-272)*. Springer.

Werbach, K., Hunter, D. (2015). *The Gamification Toolkit - Dynamics, Mechanics and Components for the Win*. Philadelphia: Wharton Digital Press.

White, R. W. (1959). Motivation Reconsidered: The Concept of Competence. In: *Psychological Review*, 66 (5), pp.297–333.

Yee, N. (2006). Motivations for Play in Online Games. In: *CyberPsychology and Behavior*, 9(6), pp.772-777.

Zichermann, G., Cunningham, W. (2011). *Gamification by Design: Implementing Game Mechanics in Web and Mobile Apps*. Sebastopol, CA: O'Reilly Media.

Zichermann, G., Linder, J. (2010). *Game-Based Marketing – Inspire Customer Loyalty through Rewards, Challenges and Contests*. Hoboken, N.J.: John Wiley & Sons, Inc.

Zichermann, G., & Linder, J. (2013). *The Gamification Revolution*. New York: McGraw- Hill Education.